資料 7.1

テクニカルノート

TECHNICAL NOTES

ON

PREPARATORY SURVEY ON THE PROJECT

FOR EXPANSION OF WATER SUPPLY SYSTEM

IN PURSAT AND SVAY RIENG

IN THE KINGDOM OF CAMBODIA

Japan International Cooperation Agency (hereinafter referred to as "JICA") has dispatched the first batch of the Preparatory Survey Team (hereinafter referred to as "the Team") headed by Mr. SAWARA, senior advisor for urban water supply, JICA to the Kingdom of Cambodia from 22 May 2017 for the purpose of preparing the Outline Design on the Project for Expansion of Water Supply System in Pursat and Svay Rieng in the Kingdom of Cambodia (hereinafter referred to as "the Project").

Since the JICA official members held discussions and conducted field surveys, Mr. KONNO, chief consultant of the Team has continued the survey. In course of field surveys and discussions on the technical aspects of the scope and basic information of the Project with the officials of the Royal Government of Cambodia (hereinafter referred to as "RGC"), both sides confirmed the items described in the Attached sheets of this note.

It is noted that the final scope of the Project, project implementation designs etc. will be decided after consultations with JICA in Japan.

Phnom Penh, 17 July 2017

Dr. Sreng Sokvung
Director
Department of Technical and Project Management
Ministry of Industry and Handicraft (MIH)

矢山将志 for

Mr. Hideki KONNO
Chief Consultant
Preparatory Survey Team
Japan International Cooperation Agency (JICA)

ATTACHMENT

1. Possible Water Sources and Intake Facilities

1) Possible Water Sources and Intake Site for Pursat City

Possible Surface Water Source for Pursat City

The Team recommended that raw water from the Pursat River be drawn for supplying domestic water to the future expansion service areas and it was agreed by the Cambodian side. Details are as below:

-MIH sent a letter to MOWRAM on May 26, 2017 for requesting additional water abstraction of 14,500m^3/day from the Pursat River, and is waiting for an answer from MOWRAM. MIH requested MOWRAM to respond to this letter by the end of July, 2017.

-The total raw water to be withdrawn from the Pursat River will be 7,200m^3/day (for the existing system) + 14,500m^3/day (for the future expansion) = 21,700m^3/day(total) =0.25m^3/s.

-Abstraction of 0.25 m^3/s will be possible because the minimum discharge from the Pursat River in 2015 when the most severe drought occurred in recent years is estimated approximately at 10 m^3/s.

Intake Site along the Pursat River

Considering the conditions of stability of the river channel, movement of sand bars with bank erosion as well as problems of inflowing muddy sediment into the pump of the existing intake facility, as a result of comparing and examining seven water intake candidate sites (see **Annex-1**), the Team recommended withdrawing from the immediate upstream of Dhamnak Ampil Headwork (Site No.A) as the best option.

The recommended second option is intake from the immediate upstream of the existing intake point (Site No.00).

2) Possible Water Sources and Intake Site for Svay Rieng City

Possible Surface Water Source for Svay Rieng City

Considering securing stable water resources and water quality, the Team recommended that raw water from the Vay Kor Lake be drawn for supplying domestic water to the future expansion service areas and it was agreed by the Cambodian side. Details are as below:

-In the same letter by MIH to MOWRAM dated May 26, 2017, MIH also requested water withdrawal of 12,100m^3/day from the Vay Kor Lake, and is waiting for an answer from MOWRAM to be sent by the end of July, 2017.

- According to estimates of the Team, if the irrigation area around Vay Kor Lake is extended to 5,500 ha as planned in the future, the necessary irrigation water volume will increase to about 36 to 44 MCM. In this case, the amount of irrigation water exceeds 30 MCM, which is storage capacity of Vay Kor Lake estimated by the Team. Therefore, it is difficult to abstract tap water from Vay Kor Lake, unless the water supply is given priority over irrigation water consumption.

Intake Site in the Vay Kor Lake

The Team compared the candidate intake sites in the Vay Kor Lake (see **Annex-2**). As per the results, the most recommendable intake site is at the north side of the road dike of National Road No.1 (NR1)

矢山　B 76

besides the existing bridge in the Vay Kor Lake (Site No.2). This is because, the water surface is near the road dike of NR1 and enough water depth during the dry season can be obtained under proper management of surface water resources of the Lake.

The both sides confirmed the other suitable sites for the second option is nothing as the results.

3) Problems of Scouring and Insufficient Flood Capacity at Vay Kor Dam

Vay Kor Dam is composed of slender reinforced concrete walls and supporting walls and concrete slab foundation and probably with concrete sheet piles under the concrete slabs.

There are the following risks attributing to instable dam body and insufficient dam structure, such as;

-scouring around the foundation

-deterioration of the reinforced concrete walls and supporting walls

-insufficient flood discharge.

The condition and problem of Vay Kor Dam is being studied by the Team through collecting information. In case the Dam collapses, it would be difficult to withdraw water from the intake site.

4) Potentiality of Groundwater Development in Svay Rieng City

Based on the hydrogeological survey results about Svay Rieng, the Team's explanation, which was also understood by the Cambodian side was as follows:

-There is a potentiality of groundwater development nearly equivalent to the present production wells. However, the detailed surveys are necessary in order to newly construct production wells because alluvium formation generally has considerable geological-facies change.

-Moreover, the Team are currently conducting groundwater quality survey, and has to evaluate the results.

2. Demand Projection

Cambodian Side confirmed the Team to conduct water demand projection by 2025, which is the target year of the National Strategic Development Plan 2014-2018 (NSDP) and 4 years after the expected completion of the Project. Water supply areas of Pursat and Svay Rieng in the target year are shown in Annex-3, respectively. 14 communes in 3 districts in Pursat and 12 communes in 3 districts in Svay Rieng shall be set as proposed water supply area.

The Team evaluated as below:

-Per Capita Consumption per day in the target year is set at 120L in Pursat and 125L in Svay Rieng based on the record from both waterworks during 2014 to 2016.

-Leakage ratio is estimated based on the non-revenue water ratio. Non-revenue water ratio is set at 12% in Pursat and 11% in Svay Rieng based on the record from both waterworks during 2014 to 2016.

-Day max. factor is set at 1.2 for both cities based on the record from both waterworks during 2014 to 2016.

-Existing water treatment plant capacity in the target year is set at 7,260m^3/day in Pursat and 4,560m^3/day in Svay Rieng. However, those capacities are to be confirmed by reviewing the scope of the ADB's Rehabilitation Project.

- It is requested that we should consider economic growth and commercial consumption when we estimate water demand.

3. Site for New Water Treatment Plant (WTP)

Site for New Water Treatment Plant for Pursat City

To select the site of a new water treatment plant in Pursat, the Team made a preliminary evaluation for eleven candidate sites, proposed by the Cambodian Side (refer to **Figure A4-1**).

As a result of discussion among the MIH, Pursat provincial waterworks and the Team, three sites (No.04, 05 and 06) were selected as candidate locations.

The reason for selection of No.04, 05 and 06, is to be located at the middle points between the potential water source (Dhamnak Ampil Headwork) and the water supply area including future expansion supply area. In addition, these sites are more adequate locations than the others to distribute water to the supply area efficiently.

Site for New Water Treatment Plant for Svay Rieng City

To select the site for a new water treatment plant in Svay Rieng, the Team made a preliminary evaluation for three candidate sites, proposed by the Cambodian Side (refer to **Figure A4-2**).

As a result of discussion among the MIH, Svay Rieng provincial waterworks and the Team, one site (No.02) was selected as a candidate location for new water treatment plant.

The reason of selection for No.02 is that it is to be located at the point relatively close to the proposed intake location and the water supply area including future expansion supply area. In addition, this site is an adequate location to distribute water to the supply area efficiently.

4. Others

Next Actions

After returning to Japan, the Team finalizes each item on consultation with JICA, which is subject to change. The results will be explained to the Cambodian Side at the start of the second field survey.

Data Request

The Team would like the Cambodian Side to deal with the following items under request from the Team by the due date. The Team wishes to report the results as below:

Table 1. Items under request from the Team

No.	Items under request	Due date
1	Data and information on the ADB rehabilitation of the existing water treatment facilities and pipeline in Svay Rieng	July 31, 2017
2	Hydrological and Meteorological data from MOWRAM	July 31, 2017
3	Reply letter on Water Rights from MOWRAM	July 31, 2017
4	Data and information on the ADB rehabilitation of the existing water treatment facilities and pipeline in Pursat	July 31, 2017
5	Priorities at the village level to be added to new water supply areas in Svay Rieng, requested by Cambodian Side	July 31, 2017

Annex-1 Comparison of Alternative Intake Sites along the Pursat River

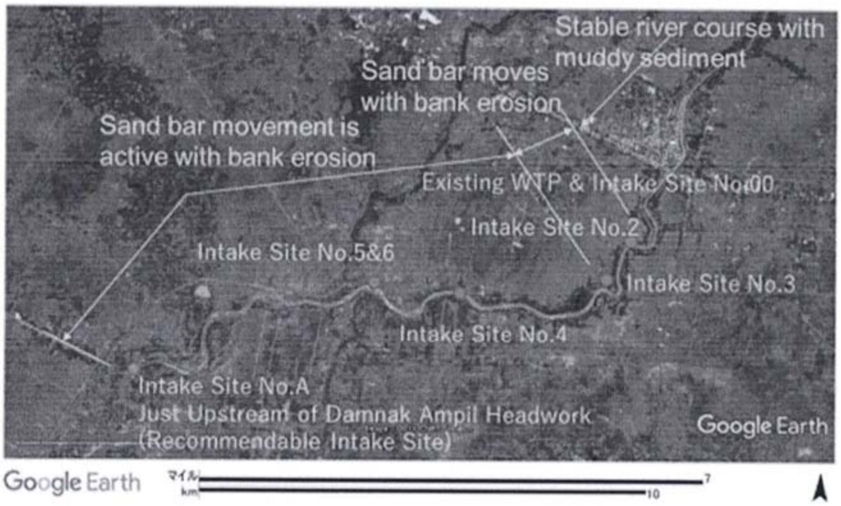


Figure A1-1 Candidate Intake Sites along the Pursat River

Table A1-1 Assessment of the Candidate Intake Sites for Domestic Water Supply along the Pursat River

Site No.	km from the existing intake	River Reach	Stability of River Course	Water Depth in Dry Season	Discharge in Dry Season	Sediment	Inundation during Flood	Site Suitability for Intake
No.00	20m upstream	Downstream	Stable	Enough near the left bank	Enough	Rather big muddy sediment in rainy season	About 1m inundation by 2006 Flood	Not so suitable
No.2	1.8km upstream near school	Downstream	Not so stable due to movement of sand bars	Shallow near the left bank	Enough	Rather big sediment with mud and sand	Not clear	Not suitable
No.3	3.0km upstream	Transition of mid-stream / downstream	Not so stable due to movement of sand bars and bank erosion	Shallow near the left bank	Enough	Rather big sediment with mud and sand	Not clear	Not suitable
No.4	6.2km upstream	Mid-stream	Not stable due to active movement of sand bars with bank erosion	Enough near the left bank	Enough	Big sandy sediment	Not clear	Not suitable
No.5 and No.6	8.1km upstream	Mid-stream	Not stable due to active movement of sand bars with bank erosion	Enough near the left bank	Enough	Big sandy sediment	Not clear	Not suitable
No. A	15.9km upstream at 15m U/S of Dhamnak Ampil Headwork	Mid-stream	Stable by Dhamnak Ampil HW's storage area	Enough near the left bank	Enough	Sandy sediment deposit in the storage area with some extent	0.3m over ground by 2006 Flood	Suitable & Recommendable

矢山　0 16

Annex-2　Comparison of Alternative Intake Sites in the Vay Kor Lake

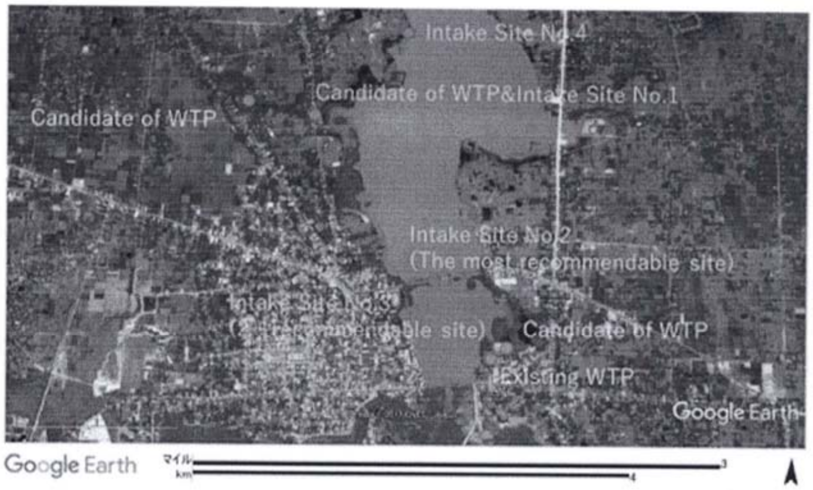


Figure A2-1 Candidate Intake Sites in the Vay Kor Lake

Table A2-1 Assessment of the Candidate Intake Sites for Domestic Water Supply in the Vay Kor Lake

Site No.	Km upstream from Vay Kor Dam	Water Surface from Bank in Dry Season	Water Depth	Inundation Floods	Environmental Protection Area	Site Suitability for Intake
No.1	About 2.6km at right bank	Long distance with about 300 to 400m from the bank	Shallow	Bank is almost equal to the max. WL of 2011 Flood	N/A	Not suitable
No.2	1.0km at right bank and upstream side beside the NR1 Bridge	Near within about 10 to 20m from the road dike of NR1	Enough	No inundation. Max. WL during 2011 Flood was about 0.5m below the shoulder of the road cum dike.	N/A	Suitable and the most recommendable site with facing bigger lake area in northern side.
No.3	760m at right bank along the road cum dike between Vay Kor Dam and NR1	Near within about 20 to 30m from the bank	Enough	No inundation. Max. WL during 2011 Flood was about 0.1 to 0.3m below the shoulder of the road cum dike.	Applicable	Not suitable
No.4	About 3.5km at right bank	Long distance with about 100m from the bank. Only small access road, which car cannot enter. No electricity line.	Shallow	Bank is almost equal to the max. WL of 2011 Flood	N/A	Not suitable

Annex-3 Water Supply Area

Tentative distribution mains in the requested area by Cambodian Side are shown in Figure A3-1 and Figure A3-2. Both sides confirmed that based on the priority of pipe extension plan, required distribution pipelines will be further considered. The priority will be confirmed based on the population, existence of other measures to obtain the drinking water and poverty condition etc.

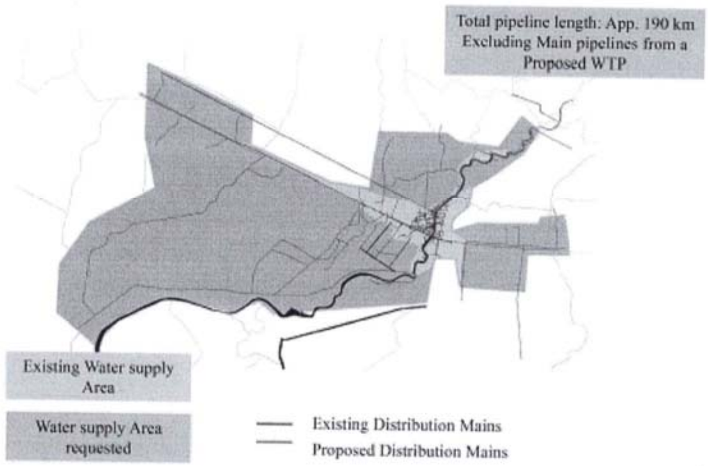


Figure A3-1 Distribution Mains in Pursat

Note) The length of the pipeline is tentative and will be further examined.

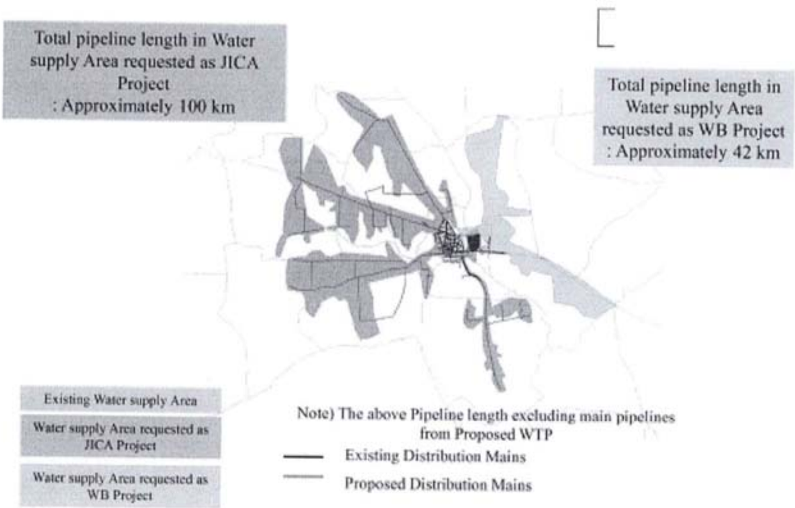


Figure A3-2 Distribution Mains in Svay Rieng

Note) The length of the pipeline is tentative and will be further examined.

Project support area will be determined with the further study on the basis of the priority plan prepared by the waterworks.

Annex-4　Candidate Site for New WTP

Eleven candidate sites for new water treatment plant in Pursat were proposed by Cambodian Side as shown in Figure A4-1.

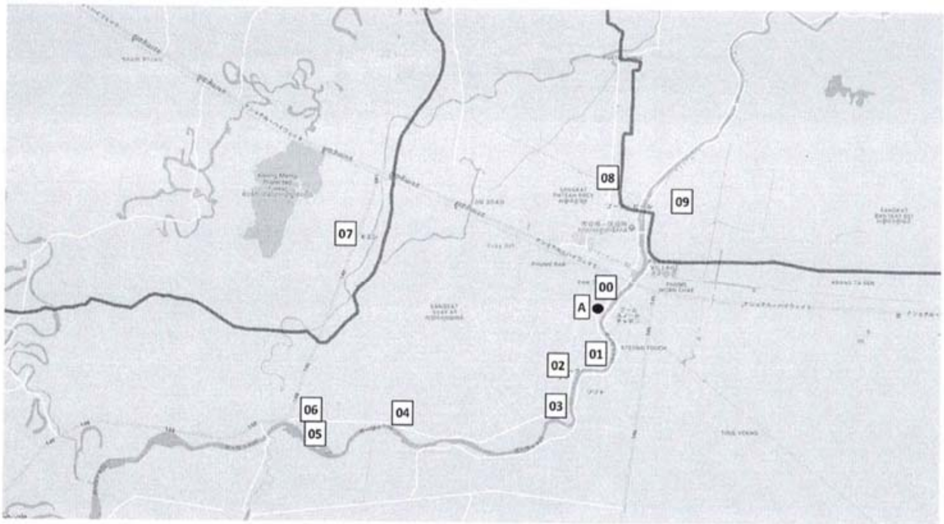


Figure A4-1 Candidate Site for New WTP in Pursat

Three candidate sites for a new water treatment plant in Svay Rieng were proposed by the Cambodian Side as shown in Figure A4-2.

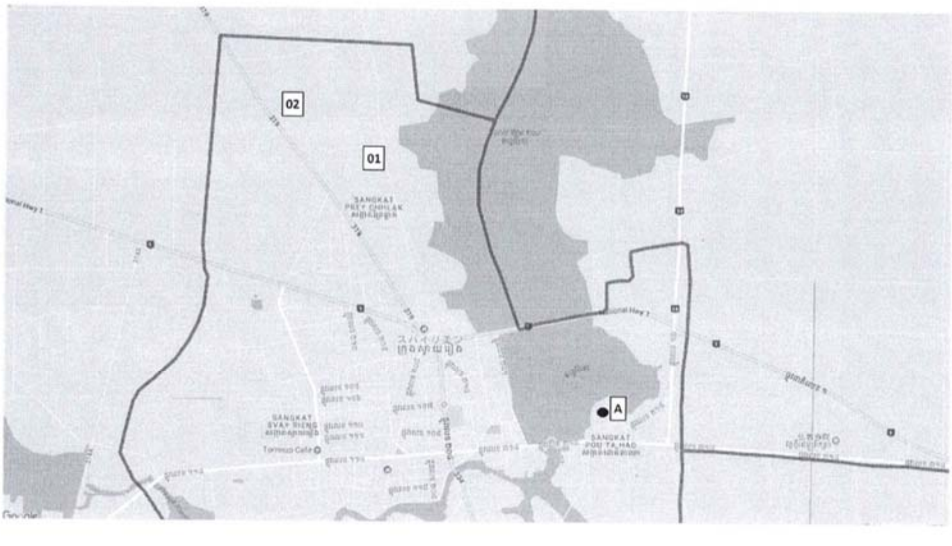


Figure A4-2 Candidate Site for New WTP in Svay Rieng

TECHNICAL NOTES
ON
THE PREPARATORY SURVEY ON THE PROJECT
FOR EXPANSION OF WATER SUPPLY SYSTEM
IN PURSAT AND SVAY RIENG
IN THE KINGDOM OF CAMBODIA

Based on the Minutes of Discussions (hereinafter referred to as "M/D") on the Preparatory Survey on the Project For Expansion of Water Supply System in Pursat and Svay Rieng in the Kingdom of Cambodia (hereinafter referred to as "the Project") signed on August 24th, 2017 between Japan International Cooperation Agency (hereinafter referred to as "JICA") and Ministry of Industry and Handicraft (hereinafter referred to as "MIH"), of the Government of Cambodia, the consultant members of the JICA Preparatory Survey Team (hereinafter referred to as "the Team") had a series of discussions and conducted field surveys from August 9th and will continue until September 4th, 2017.

As a result of the discussions and the surveys, both sides (MIH and the Team) confirmed the technical conditions described in the attached sheets of this note.

It should be noted that this technical note does not mean the commitment of the project scope, project implementation, design and method to be implemented. The final project scope, project implementation, designs, etc. will be decided by the Government of Japan.

Phnom Penh, September 1st, 2017

Dr. Sreng Sokvung	Mr. Hideki KONNO
Director	Chief Consultant
Department of Technical and Project Management	Preparatory Survey Team
Ministry of Industry and Handicraft (MIH)	Japan International Cooperation Agency (JICA)

1

ATTACHMENT

Both sides agreed upon and confirmed the following items.

Pursat

1. Location of Water Intake and Water Treatment Plant (WTP)

The Team explained the comparison results of the new intake site alternatives in the Pursat River with combination of the new WTP candidate sites as shown in **Annex-1**.

Case 1: New Intake Facility at upstream of Dhamnak Ampil Headwork and the new WTP at Site No.5

- New intake site in the impounding area of Dhamnak Ampil Headwork at about 220m upstream from the Headwork.
- New WTP site at Site No.5
- Raw water transmission pipeline from the new intake site to the new WTP (L= about 8km)

Case 2: New Intake Facility at just upstream of the existing Intake Pumping Station and new WTP at Site No.2

- New intake site at about 50m upstream from the existing Intake Pumping Station.
- New WTP site at Site No.2
- Raw water transmission pipeline from the new intake site to the new WTP (L= about 1.5km)

Comparison was conducted by comprehensive way from the viewpoints of water sources, sediment problem to the intake facility, investment cost, operation and maintenance (O&M) including replacement of equipment, O&M cost, and social problems.

Case 1 has advantage in much higher stability of water source, less sediment problem, less investment cost and less social problems. Disadvantage is higher on O&M cost. There is less flooding problem around the new WTP site at Site No.5 (inundation depth of about 1m in 1996 and 2006 Floods).

Case 2 has rather stable water sources, but less stable than Case 1. Case 2 has more sediment problem, higher investment cost and less O&M cost. Case 2 has more social problems especially related to the access road to the new WTP. Furthermore, the new WTP site is located in the flood inundation area during 1996 Flood and 2006 Flood with inundation depth of about 2m.

- Based on the above comparison results, Japanese side (JICA and the Team) and Cambodian Side (MIH, Pursat District of Industry and Handicraft (DIH) and Pursat Waterworks) agreed to select the Case 1 on the Minutes of Discussion signed on August 24 in 2017.
- Furthermore, considering the problem of damage to the existing intake pump and the importance of sediment settling facility in the existing WTP, both sides agreed that coarse and fine sediment up to 0.08mm diameter is to be removed as much as possible just after taking water from the impounding area of Dhamnak Ampil Headwork before sending water from the Intake facility to the New WTP at

Site No.5 by using pump. For this purpose, sediment settling facility will be installed at the new intake site.

2. Intake Facilities

The Team explained alternative intake pumps such as vertical mixed flow pumps and horizontal end suction pumps. The Team also recommended that it is better to adopt horizontal end suction pump because of easier maintenance and less consumable parts than vertical mixed flow pump which is now using in the existing intake pump station. MIH agreed to the recommendation.

With reference to the method of abstracting water from Pursat River, the Team explained two alternative methods such as open channel type (see **Figure A2-1** in **Annex-2)** and horizontal suction pipe with strainer which is the same water intake method as the existing facility. MIH agreed to adopt the open channel type because it is easy to clean out the sediment in the intake passage. The outline specification for intake facility is shown in **Table A2-1** in **Annex-2**.

Sluice gates shall be installed at the intake mouth of channel for stoppage of flowing water. Grit chambers were recommended to be constructed in front of the pump suction pit to remove sand. To protect from erosion, appropriate bank protection shall be constructed at extend of 20m length to upstream and downstream.

3. Land for WTP

To select the site of a new WTP, the Team made a preliminary evaluation for eleven candidate sites, proposed by the Cambodian Side (MIH, Pursat DIH and Pursat Waterworks) (refer to **Figure A3-1** in **Annex-3**).

As a result of discussion among MIH, Pursat provincial waterworks and the Team, one site (Site No.5) was selected as candidate location (refer to **Figure A3-2** in **Annex-3**).

The reason of selection for Site No.5 is to be located at the middle points between the potential water source (Dhamnak Ampil Headwork) and the water supply area including future expansion supply area. In addition, this site is most adequate than the others to distribute water to the supply area efficiently.

And MIH, Pursat provincial waterworks and the Team discussed the layout and design condition of new WTP which needs further discussion for finalization. (refer to **Figure A3-3** and **Table A3-1** in **Annex-3**).

MIH requested to the Team more detail information about comparison of the alternative WTP layouts. The Team agreed to provide more detail information and continuous discussion with MIH.

4. Future Supply Area and Distribution System

The Team and MIH agreed on the future supply area shown in **Annex-4**. The number of related water supply areas are 13 communes in 3 Districts.

The area was comprehensively decided in terms of the piped water supply service ratios in the area, especially in the urban area, investment efficiency and sustainability of water supply operation, based on the results of the preliminary studies including case setting of the study area, estimation of increased population served and increased maximum daily supply in the area, preliminary design of whole water supply facilities, cost estimation for initial construction, renewal, operation and maintenance, and cost-benefit analysis.

The Team explained the design policy (draft) as shown in **Annex-5** to Cambodian side (MIH, Pursat DIH and Pursat provincial waterworks) and Cambodian side agreed the design policy. The Team explained the alternative concept of the distribution system in Pursat as shown in **Table A6-1** in **Annex-6**.

- Alternative (A): Distribution pumps directly distribute water to the service area.
- Alternative (B): Distribution pumps directly distribute water to the service area and also send water to elevated tank to regulate the distribution flow or control water pressure in the service area.

MIH requested more detail information about merit and demerit of the above two alternatives. The Team agreed to provide more detail information and continuous discussion with MIH.

5. Demand Projection

MIH requested the Team to conduct water demand projection in 2025, which is the target year of the National Strategic Development Plan 2014-2018 (NSDP) and 4 years after the expected completion of the Project. MIH explained that the target service ratio shall be 90 % by piped water and remaining 10% will be covered by other measures. The Team explained that the design service ratio on this Project will be about 85% for urban area. The definition of urban area is based on the "Reclassification of Urban Areas in Cambodia, 2011 by National Institute of Statistics, Ministry of Planning".

The Team explained other factors for the demand projection as below;

- Future population is based on the following information.
  - Results of 1998, 2008 and 2013 census.
  - Village level population data between 2006 to 2015 from Pursat provincial waterworks.
  - Village level population data from the study result of JICA technical assistance project "The Project on Capacity Building for Water Supply System Phase 3 in Cambodia"
- Water supply areas of Pursat in the target year are 13 communes in 3 districts shall be set as proposed water supply area.
  - Per Capita Consumption per day for domestic water in the target year is set as 100L based on the record from Pursat provincial waterworks during 2014 to 2016.
- Non-revenue water ratio is set to 15% based on the ministerial ordinance of the MIH. Leakage ratio is set to 11.3% which is 75% of non-revenue water ratio based on past experience of similar projects.
- Day max. factor is set as 1.2 for both cities based on the record from both waterworks during 2014 to 2016.
- Existing WTP capacity in the target year is set as 7,260m^3/day.

The Team explained that based on the estimation, the capacity needed by the Project in 2025 is about 6,600m^3/day for Pursat.

6. Social and Environmental Considerations

MIH agreed to play the main role of conducting Initial Environmental Impacts Assessment (IEIA) and Public Hearing. Both sides agreed that the IEIA report should be prepared by the firm which has the license of

Ministry of Environment. Both sides (MIH and the Team) confirmed that the resettlement would not occur in the project implementation and the land acquisition would be conducted in accordance with the JICA guidelines.

7. Land Acquisition by Cambodian Side

- Cambodian side (MIH, Pursat DIH and Pursat Waterworks) promises to acquire land for intake and WTP facilities by December 31, 2017.

8. Securing of Water Intake Permission

- MIH issued the letter to Ministry of Water Resources and Meteorology (MOWRAM) for water right for urban water supply in the beginning of June. 2017. The Team requested MIH to secure permission from MOWRAM for intake amount at the agreed location by September 15, 2017.

9. Confirmation of the Request

Cambodian side (MIH, Pursat DIH and Pursat Waterworks) requested the following items to be procured under this Project.

Item		Contents
Equipment	Water quality analyzer	Distillation apparatus, Micro scope, Reagents, Glassware, pH meter, Turbidity meter, UPS, Jar Tester, Residual Chlorine meter, Conductivity meter, Spectrophotometer, Refrigerator (for reagent)
	Maintenance tools of Electrical and Mechanical	Power tester, Vibration checker, Torque Wrench, Handy Flow Meter, Filtration Sand Tester
	Accounting system	SUMS System
	Distribution management tools	Pipe laying (socket fusion)

10. Schedule of the Project

The project schedule for expansion of water supply system in Pursat is as follows.

Item	2017								2018					
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
Preparation in Japan	□													
First Field Survey in Cambodia	■	■												
Work in Japan			□											
Second Field Survey in Cambodia				■										
Analysis in Japan					□	□	□	□	□	□				
Briefing Outline Design to Cambodian Side										■				
Submission of Preparatory Survey Report												Δ		
Key Meetings with Cambodian Side	Δ	Δ		Δ						Δ				

11. Others

- Regarding operation and maintenance for new facilities, the Team recommended strengthening capacity for financial management such as utilization of SUMS system and recruitment of new staff and their training.
- MIH explained that they are on the process of preparing criteria, standards, and guidelines for water supply planning and design for more than 5,000 house connections.
- The Team explained major undertakings to be taken by the Recipient Government such as securing permission from related ministries for construction of facilities, connection of water supply pipe and meters, securing of access road for construction, drawing of electricity line, proper operation and maintenance of facilities and various tax exemption to purchase of the products and/or the services.
- As for the individual house connection for poor households, necessity of provision of the materials such as water meters, fittings and pipes in the Project will be examined in consideration of similar projects. MIH and the Team confirmed that MIH will bear the cost for installation works.
- MIH provides temporary yards and dump sites in Pursat for the Project. MIH acquired the candidate sites as shown in following table and figure as of August 2017. If these sites are not available for the Project in future, MIH shall prepare alternative sites which are same size.

Information of temporary yards and dump sites in Pursat (refer to **Annex-7**)

No	Purpose of use	Size	Area
①	Temporary Yard	100m x 200m	2.0ha
②	Temporary Yard	300m x 300m	9.0ha
③	Temporary Yard	100m x 15m	0.15ha
④	Dump Site	70m x 105m	0.74ha
⑤	Dump Site	55m x 210m	1.16ha

Svay Rieng

1. Possibility of Water Sources and Modification of the Preparatory Survey

The Team explained the following problems of Vay Kor Dam. By these problems, it is not possible to secure long-term safety of taking raw water from the Vay Kor Lake. Photos and sketch of Vay Kor Dam structure are shown in **Annex-8**.

a) Scouring around foundation

There is a possibility of causing damage to Vay Kor Dam or possibility of collapsing the Dam (even partially) due to recurrence of scouring at the foundation portion of the Dam. If the Dam is damaged, water in Vay Kor Dam will flow out, and the reservoir will be empty.

b) Deterioration of the reinforced concrete and supporting walls

There is a possibility of causing damage to the structure of Vay Kor Dam or possibility of partial collapsing of the Dam due to deterioration of the supporting walls and concrete walls of the Dam.

c) Insufficient stability of the dam structure

Vay Kor Dam cannot secure the stability against sliding and overturning with or without of riprap in the downstream side as counterweight. If the Dam is collapsed (even partially), water will flow out from the Lake.

d) Insufficient flood discharge.

Flood safety level of Vay Kor Dam is low with only 5 to 10-year return period of floods due to insufficient discharge capacity of the overflow portion of the Dam. Normally, the flood safety level of this kind of Dam (weir) should be more than 50-year return period of flood.

In addition, the discharge capacity of the Bridge at just downstream of Vay Kor Dam is also small.

There is a risk of overflowing over the Road Dike in the south end of the Lake during bigger floods such as flood of more than 20-year return period of floods. If this occurs, the Road Dike will collapse (even partially), and water in the reservoir will flow out and the reservoir will be empty.

Cambodian side (MIH, Svay Rieng DIH and Svay Rieng Waterworks) understood the above problems of Vay Kor Dam.

MIH and the Team also understood that it may be difficult or take long time to reconstruct Vay Kor Dam for ensuring the structural stability and securing enough safety against floods and scouring. Also, it may be difficult or take long time to improve the Road Dike for securing enough safety against floods.

Finally, Cambodian side expressed their expectation of continuing the Preparatory Survey by changing water source from surface water to groundwater.

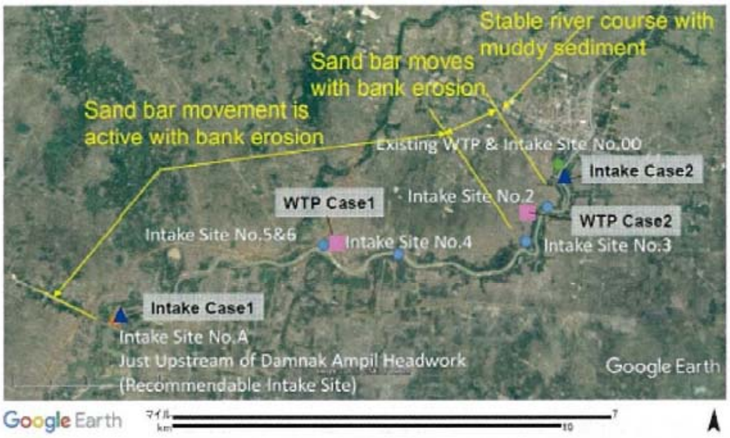
Considering the expectation, the Team will study necessary modification of the contents and schedule of the Survey for Svay Rieng, and will inform the results to Cambodian side. The Team also explained the necessity of additional surveys on groundwater source in Svay Rieng such as geophysical survey, test well drilling survey, pumping test survey and so on.

2. Further Study for Expansion of Water Supply System in Svay Rieng

The following survey and study will be conducted in the next field survey after the revision of project contents and schedule for Svay Rieng.

- Confirmation of Land for New WTP.
- Future Supply Area and Distribution System
- Demand Projection
- Confirmation of the Request Items
- Securing of Permission from MOWRAM for Water Right

Annex-1　Intake and WTP Site in Pursat



	Case1 (Intake：Dhamnak Ampil, WTP：No.5)	Case2 (Intake：near the existing intake point, WTP：No.2)
Plan Drawing		
Outline of Intake Site and Facilities	**Site Condition** - WL Condition: LWL+16.300m, HWL+18.200m Water Level Fluctuation:1.9m - Land: 100mx100m (Intake and Yard for Construction) - 1.0m of inundation depth from the ground in 1996 and 2006 **Civil Work** - Conveyance Pipe: DIP350 x 8,000m - Pump Room and ancillary works : LxWxH=37.3mx8.4mx10.5m - Generator Room: LxWxH=6mx5mx4m - Land Creation: 0.5m up (EL18.070m→EL18.570m) **Temporary Work** - Coffer Dam of River Side, Steel Sheet Pile SP-III - Excavation by Open Cut **Mechanical Works** - Pump Type: Horizontal End Suction Pump - Pump Head:37m - Pump :150mm/ 2duty +1 stand-by/ 30kW - Q=5.04m3/min	**Site Condition** - WL Condition: LWL+11.635m, HWL+17.635m Water Level Fluctuation:6.0m - Land: 50mx50m, Residential houses are adjacent. (Intake and Yard for Construction) - Flood Prone Area, 2.0m of inundation depth from the ground in 1996 and 2006 **Civil Work** - Conveyance Pipe: DIP350 x 1,500m - Size of Pump Room and ancillary works : LxWxH=44.0mx8.1mx14.5m - Generator Room: LxWxH=6mx5mx4m - Land Creation: 2.0m up (EL16.135m→EL18.135m) **Temporary Work** - Coffer Dam of River Side, Steel Sheet Pile SP-IV - Retaining Wall for Civil Work Construction SP-IV **Mechanical Works** - Pump Type: Horizontal End Suction Pump - Pump Head:21m - Pump :150mm/ 2duty +1 stand-by/ 15kW - Q=5.04m3/min
Outline of WTP Site and Facilities	**Site Condition** - Candidate Site No.5 - Area:100mx100m - 1.0m of inundation depth from the ground in 1996 and 2006 - Distance from the River: Approx.400m	**Site Condition** - Candidate Site No.2 - Area:100mx100m, Elementary school is adjacent. - Flood Prone Area, 2.0m of inundation depth from the ground in 1996 and 2006 - Distance from the River: Approx.400m - 4 Residential Houses along Access Road

		Case1 (Intake：Dhamnak Ampil, WTP：No.5)	Case2 (Intake：near the existing intake point, WTP：No.2)
		Civil Work - Land Creation: 1.0m up (EL17.650m→EL18.650m) - Land Creation of Access Road: not Required (EL18.650m) **Temporary Work** - Access from the Main Road	**Civil Work** - Land Creation: 2.0m up (EL15.260m→EL17.260m) - Land Creation of Access Road: 1.0m (EL16.260m→EL17.260m) **Temporary Work** - Construction Road: L=500m, W=10m
Status of the water source	Stability of water intake	○Stable river channel ○ Proven track records of the water intake for the irrigation ○ Sufficient amount of water and water depth in the dry season	○Stable river channel ○ Located near the existing water intake facilities (upstream side) ○ Sufficient amount of water and water depth in the dry season
	Situation of sediment	○ Coarse sand and a certain amount of floating sand accumulate in the flooded pond of the weir. ○ The flow is relatively slow because of the wide flooded pond, and the migration and floating of the silt part are less. ○ Sedimentation volume is less than Case2 and the damage to the intake pump will be less.	▲Move of sandy soil (bedload, floating sand wash load) is relatively large. ▲The flow is relatively fast and the silt is easy to move and float. ▲Sedimentation volume is more than Case1 and the damage to the pump will be more.
Construction	Workability	○ Large-scale temporary facilities are unnecessary because changes in the water level during the dry season and rainy season are small. ○The traffic of heavy construction machinery is easy because of flat ground shape and the stability of heavy construction machinery can be secured. ○Easy access from the main road. ○ Construction period for pump station is relatively short because the scale of the facilities (sedimentation basin and pumping station) are smaller than Case 2. ▲It takes time to install conveyance pipes because of long distance.	▲Large-scale temporary earth retaining work is required, because changes in the water level during the dry season and rainy season are large and houses are adjacent to facilities. ▲The traffic of heavy construction machinery is difficult due to the narrow space of intake site and the stability of rough terrain crane with vibro hammer cannot be secured due to the unevenness of ground surface shape. ▲It is difficult to carry in/out construction vehicles, because the access road to the WTP is narrow and passes through a residential area. It is required the embankment and widening of the existing access road, or the provision of new construction road. ▲Construction period for pump station is relatively long because the scales of the facilities (pump station and ancillary works) are larger than Case 1. ○ The conveyance pipe is short, so the construction period is short.
	Impact on surrounding environment	○ Neighboring construction is not required because there are few adjacent houses at the intake pump station and the WTP site. ○There is no houses near the WTP site ○There is no important facilities near WTP site.	▲Neighboring construction is required because there are houses around the intake facility. ▲Impact on houses by widening the access road to the WTP site. ▲Using the school route of elementary school as the access road to the treatment plant is not preferred for safety reasons. It must be set such as the detour path or the temporary school road. In addition, there is the possibility that adverse effects on the school activities by noise and vibration during the construction will occur. Therefore, measures must be taken against them.

		Case1 （Intake：Dhamnak Ampil, WTP：No.5）	Case2 （Intake：near the existing intake point, WTP：No.2）
Facilities	Civil engineering facility	○ Both pumping station and ancillary works of the water intake point are smaller than those of Case 2. ○The risk of flooding is small, and the height of land forming is low. ▲ The water conveyance pipe extension is long (8.0 km).	▲Both pumping station and ancillary works of the water intake point are larger than those of Case 1. ▲Since WTP site is in flood prone, it is necessary to raise the ground (about 2 m, in 1996 and 2006). ○ The water conveyance pipe extension is relatively short (1.5 km).
	Electromechanical equipment	▲Large motor output. Electricity cost is higher than Case2.	○ Small motor output. Electricity cost is lower than Case1.
Operation and Maintenance		○ The cleaning and parts exchange frequency of the sand sedimentation is low. ▲The distance is far between the WTP and the intake pump station.	▲The cleaning and parts exchange frequency of the sedimentation basin is high. ○ Easy access between the WTP and the intake pump station
Cost	JPY	○Initial cost：344,633 (thousand yen) ：36,531(thousand yen/year) ▲Running cost ：24,616 (thousand yen/year)	▲Initial cost：423,067 (thousand yen) ：44,845 (thousand yen/year) ○Running cost ：22,054 (thousand yen/year)
	KHR	○Initial cost：12,135 (million riel) ：1,286(million riel/year) ▲Running cost：867 (million riel /year)	▲Initial cost：14,897 (million riel) ：1,579 (million riel/year) ○Running cost：777 (million riel/year)

【JPY】

Unit: Thousand Yen/Year

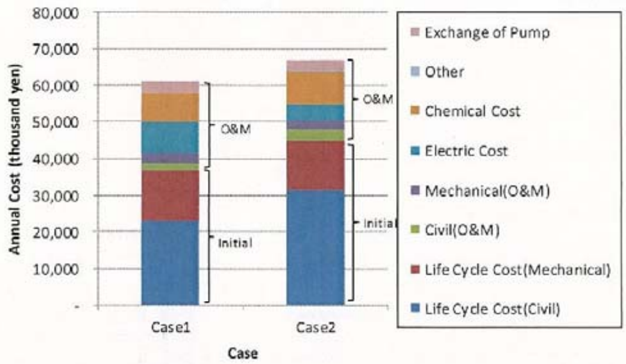
	Life Cycle Cost			O&M						Exchange of Pump	OM + Exchange of Pump	Total
	Civil	Mechanical	sub-total	Civil(O&M)	Mechanical (O&M)	Electric	Chemical	Other	sub-total			
Case1	22,928	13,603	36,531	2,163	2,567	8,801	7,759	75	21,365	3,251	24,616	61,147
Case2	31,660	13,185	44,845	2,987	2,488	4,401	8,819	208	18,902	3,151	22,054	66,899

【KHR】

Unit: Million Riel/Year

	Life Cycle Cost			O&M						Exchange of Pump	OM + Exchange of Pump	Total
	Civil	Mechanical	sub-total	Civil(O&M)	Mechanical (O&M)	Electric	Chemical	Other	sub-total			
Case1	807	479	1,286	76	90	310	273	3	752	114	867	2,153
Case2	1,115	464	1,579	105	88	155	311	7	666	111	777	2,356

Note: O&M cost of civil work is 1% of initial cost. The initial cost of civil work includes the cost of temporary work.
O&M cost of mechanical work is 2% of initial cost.

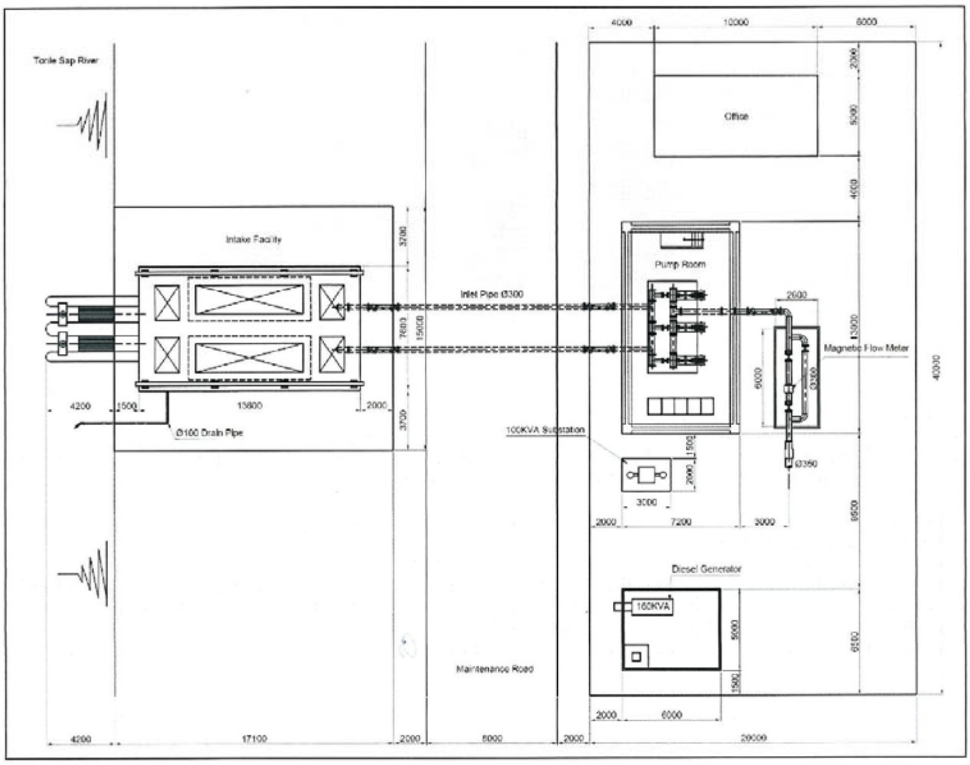


Note:

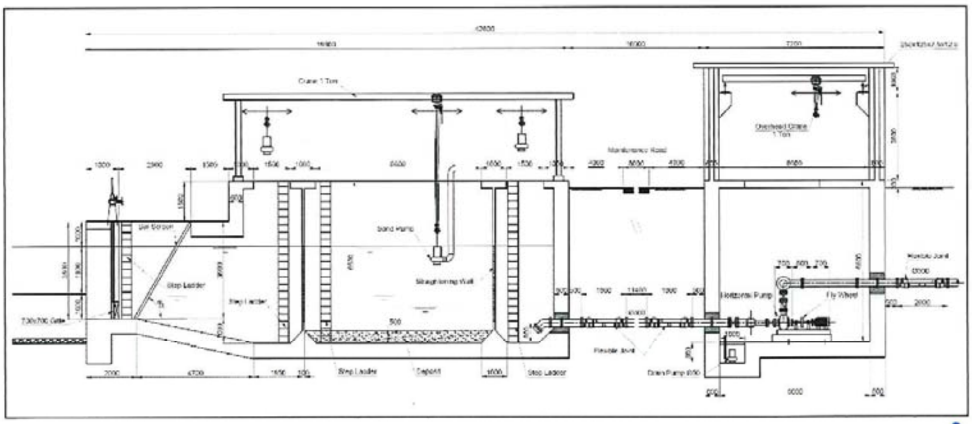
1. *1 JPY=approx. . 37.4 riel(as of August 24, 2017)*
2. *The above comparison is based on the cost for yearly basis during lifecycle time.*
3. *The gap of electricity cost between Case 1 and Case 2 is approximately 4,400,000 yen/year （approx.164, 560,000 riel）. The gap of cost for 30 years is approximately 75,000,000 yen as the present value*

4. *Initial costs are calculated by annual expense ratio (cost ratio for 1 year) during the life cycle (30 years). The annual expense ratio is calculated by the following equation:*
   Annual expense ratio = r/(1-(1+r)-n), where, r: Interest Rate, n: Operation Years
5. *Replacement Cost for vertical axis pump with inclined flow is estimated by pump life (15 years). The cost for replacement is the cost incurred by replacement taking the discount rate at the time of replacement into account to calculate the present value. The discount rate is calculated by the following formula:*
   Discount Rate = 1/(1+r)n; where, r: Interest Rate, n: Operation Years

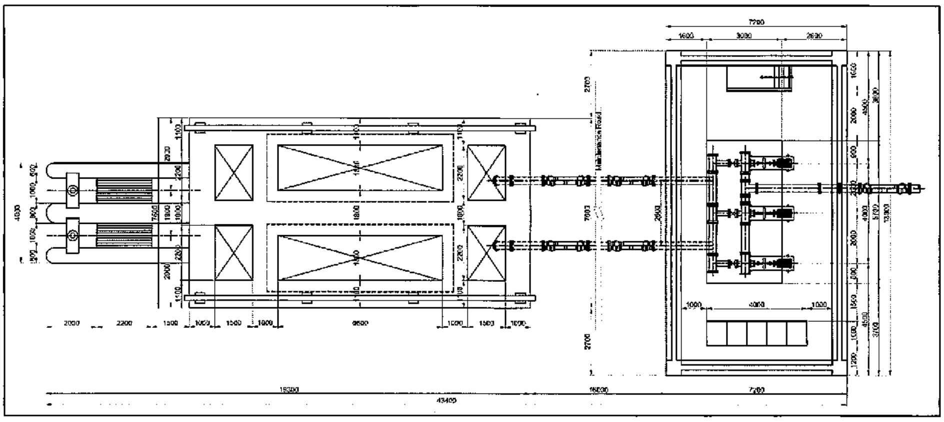
Annex-2　Intake Facility



Layout of Intake Facility



Section



Plan

Figure A2-1　General Drawing of Intake Facility

Table A2-1　Outline Specification for Intake Facility

No.	Item	Specification
Mechanical		
1	Standards	ISO, IEC, JIS, JEC
2	Pump type	Horizontal, end suction volute pump
3	Spare pump	1 set
4	Number of duty pump	2 set
5	Flow control system	Pump quantity control by manual
6	Intake type	Open channel type
7	Counter measure of water hammer	Flywheel type
8	Discharge method of sand	Sand submersible drainage pump
9	Crane type	Manual type, overhead crane
10	Intake screen	Steel bar screen
11	Sand discharge	Pursat river
12	Flange standard	ISO PN10
Electrical		
1	Standards	ISO, IEC, JIS, JEC
2	Monitoring items transmitted to WTP	- Flow rate - Integrate trouble - River side and pump pit water levels - Pump operation - Electric power source
3	Signal transmission method	Internet communication line
	Substation	22/0.4kV from EDC power line, received in pump station
4	Water flow meter	Magnetic type flow meter, installed in pit
5	Level meters	4-20mA signal, installed river and pump pit
6	Emergency diesel generator	100% capacity for all lords
7	Capacity of fuel tank	For 10hrs operation
8	Power factor at WH meter	0.95
9	Rated voltage of motors	380V/3-phase and 220V/single phase

Annex-3　Location and Layout of New WTP in Pursat

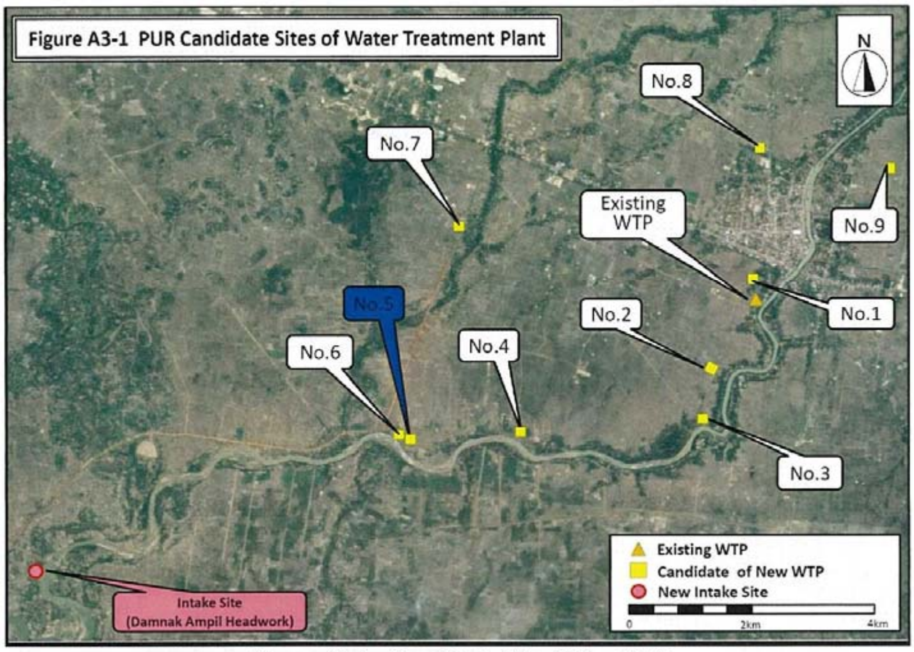


Figure A3-1　Candidate Site of New WTP

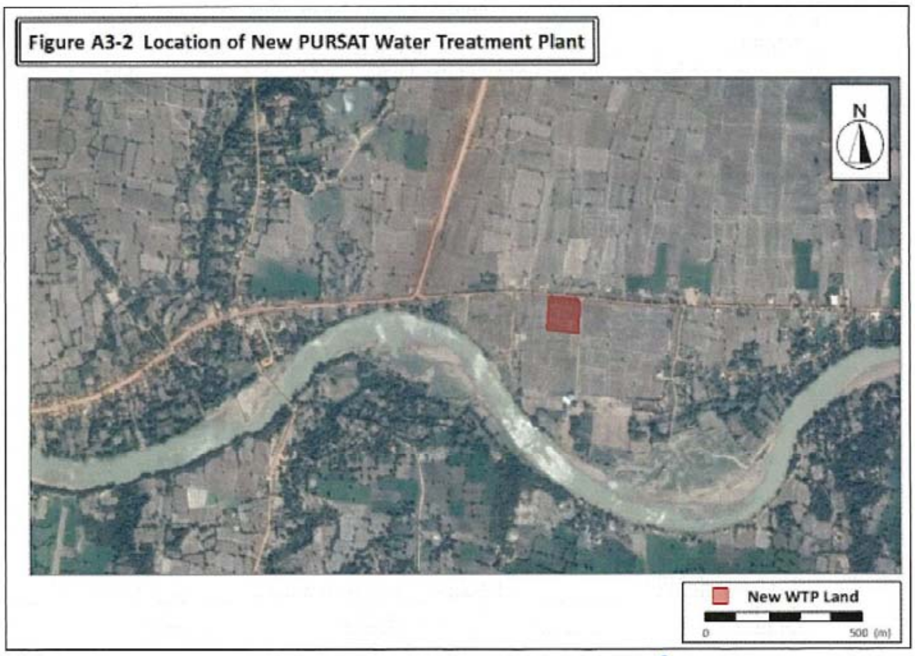


Figure A3-2　Location of New WTP

14

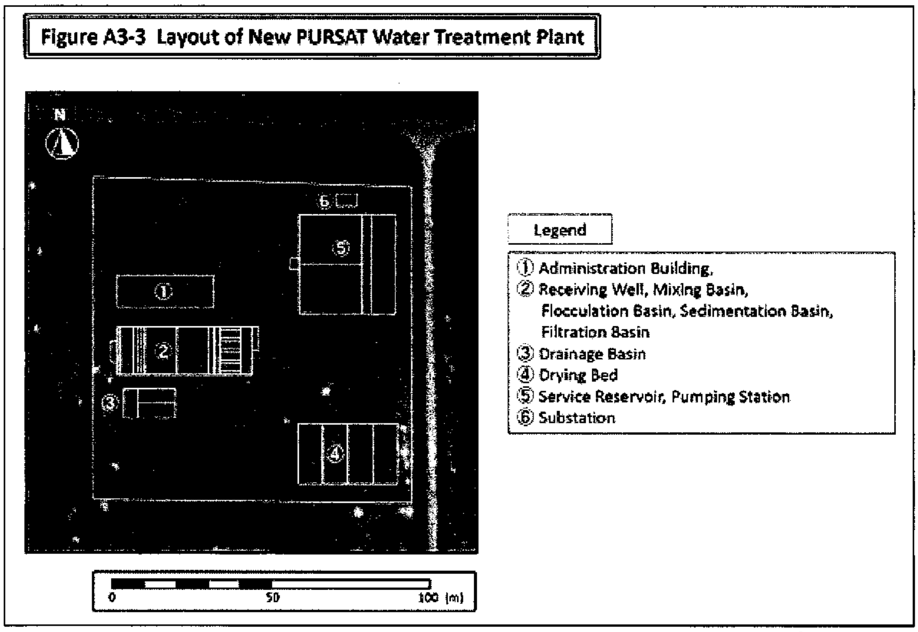


Figure A3-3　Layout of New WTP (one of the alternative layouts)

15

Table A3-1 Design Condition of New WTP

Name of Equipment & Facilities, etc.	Design criteria applied to the project			Reference: Japanese Design Criteria	Reference: Example of similar projects in Cambodia	Reference: Request
Civil Architectural Mechanical Electrical						
Raw Water			Pursat River	Well, River, Lake, Pond	River	River
Selection of water treatment methods and water treatment facilities	Selection of water treatment methods and water treatment facilities	Selection of water treatment methods	Rapid sand filtration method	>Disinfection only >Slow sand filtration method >Rapid sand filtration method >Membrane filtration method >Advanced treatment method >Other treatment method	Rapid sand filtration method	
	Wastewater treatment	Sludge treatment type (Sludge of Sedimentation Basin)	Drying bed>>To carry out the dried sludge cake and dispose of it.	>Drying bed >Machine dehydrator >Dehydrating thermal dry	Drying bed >>To carry out the dried sludge cake and its dispose.	
		Wastewater treatment type (backwashing water of filter)	Returning from the wastewater basin to the receiving well.		Returning from the wastewater basin to the receiving well.	
Receiving well	Structure and volume		The one basin has two divisions with a perforated baffle.	Two divisions. Drainage facilities and overflow facilities	The one basin has two divisions with a perforated baffle.	
			More than 1.5min (Target value: about 3min)	More than 1.5min	Retention time about 3min	
Feeding facility of coagulants	Coagulants	Coagulant type	PAC (Polyaluminum chloride)	>Aluminum sulfate >Polyaluminum chloride >Ferric chloride >Polysilicic iron	Aluminum sulfate	PAC (Polyaluminum chloride)
	Acid and alkali agents		Lime	>Lime >Sodium carbonate >Sodium hydrate	Lime	Lime
Mixing basin	Structure and type		Methods to utilize the energy of water flow itself(Weir type)	>Methods to give mechanical energy from outside >Methods to utilize the energy of water flow	Methods to utilize the energy of water flow itself (Weir type)	

Name of Equipment & Facilities, etc.	Design criteria applied to the project			Reference		
				Japanese Design Criteria	Example of similar projects in Cambodia	Request
				itself (Weir type, partial flume type, water jump type)		
	Retention time		> 1-5 min (Target value : about 1.5 min)	1 - 5 min	1-2min	
Flocculation basins	Structure and type		Methods to utilize the energy of water flow itself		Methods to utilize the energy of water flow itself	
	The number of basins		2 basins		2-4 basins	
	Shape		Roundabout flow type	>Mechanical stirring method > Roundabout flow type > Horizontal zigzag flow type	Roundabout flow type	
	Retention time		Retention time 20 - 40min	20 - 40 min	Retention time 26.4 - 60.9 min (Dray season)	
Chemical sedimentation basin	Composition and structure	Type	Intermediate takeout type sedimentation basin	>Horizontal flow type sedimentation basins >Sloping-plate (tube) type sedimentation basin (Horizontal flow) >Sloping-plate (tube) type sedimentation basin (Upward flow) >Suspended solid contact clarifier	Intermediate takeout type sedimentation basin	
		Number of basins	2 basins	Over two basins principally.	2-4 basins	
		Effective depth	3 – 4m	3 - 4m	3.5-4.12m	
	Horizontal flow sedimentation basin	Overflow rate	Standard range 15 - 30mm/min (Target value: about 20mm/min)	>Single-floored type: Standard range 15 - 30mm/min >Multi-story type: Standard range 15 25mm/min	Surface Load: Q/A=19-20.0mm/min	
	Desludging facilities		Desludging valves (Cleaning the inside of sedimentation basin every two month)	Apply a proper method. Close at power outage.	Desludging valves (Cleaning the inside of sedimentation basin every	

17

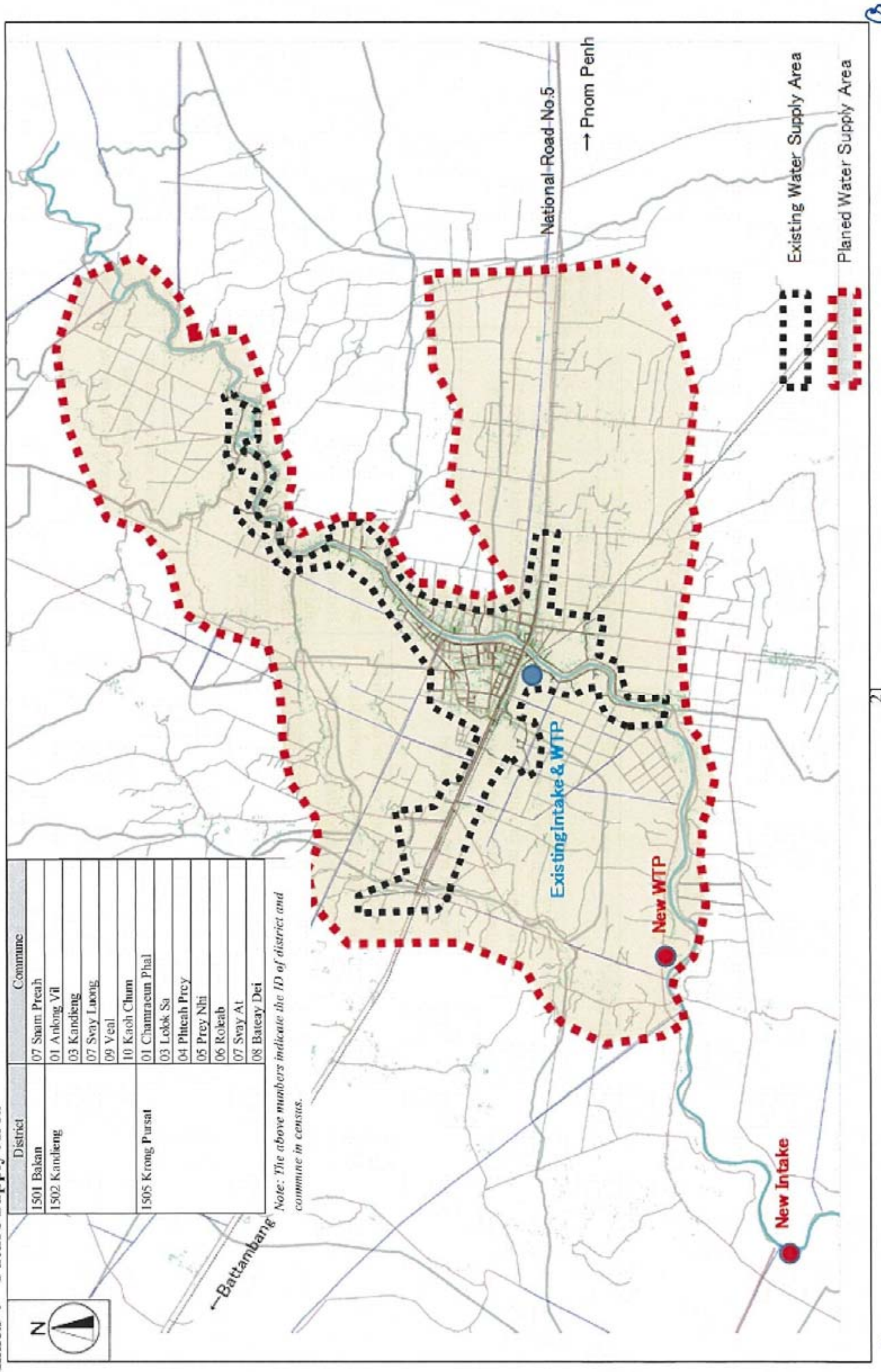
Name of Equipment & Facilities, etc.	Design criteria applied to the project			Reference: Japanese Design Criteria	Reference: Example of similar projects in Cambodia	Reference: Request
					two month)	
Rapid sand filters	Structure and type		Gravity type	Gravity filtration (Standard)	Gravity type	
	Filter bed area, number of filter units and shape	Filter units	4 basins	Over two basins	6 basins	
		Standby filter units	Nothing	One basin per ten basins	Nothing	
		Filter bed area	Less than 150m2 per one basin	The filter bed area per filter shall be less than 150 m2.	17.5m2 (From the drawings)	
		Shape	Rectangle	Rectangle	Rectangle	
	Filtration rate controller		Downstream flow control method	A device to control the flow of filtration shall be installed.	Downstream flow control method	
	Filtration rate		120 - 150m/d (Target Value: About. 120m/d)	120 - 150m/d	120m/d(about.)	
	Filter sand and its depth	Effective diameter	Effective diameter 1.0mm	0.45 - 0.75 mm (for surface washing) Don't describe for Airwash		For Backwash + Air wash
		Uniformity coefficient	Uniformity coefficient less than 1.7	Less than 1.7		
		Depth of sand	Depth of sand 100cm	60 - 70cm	Depth of sand: 100cm	For Backwash + Air wash
	Underdrain system		Porous plate type Only nozzle block type	>(Perforated) block type >Strainer(nozzle) type >Perforated pipe type >Porous plate type	Porous plate type block type	
	Type of washing		Backwash + Air wash	>Backwash+Surface wash >Backwash + Air wash	Backwash + Air wash	
Disinfection facilities	Types of chlorine agents, dosage and points of dosage	Type of chlorine agents	Powder (Calcium hypochlorite)	>Sodium hypochlorite >Liquid Chlorine >Calcium hypochlorite	Liquid Chlorine	Powder (Calcium hypochlorite)
		Points of dosage	Mixing basin Outlet of sand filter	>Receiving well >Chlorine mixing chamber >The entrance to the clear	Mixing basin Outlet of sand filter	

18

Name of Equipment & Facilities, etc.	Design criteria applied to the project			Reference		
				Japanese Design Criteria	Example of similar projects in Cambodia	Request
				water		
Drainage basin	Number of basins Water Depth		2 basins 2 - 4m	More than two basins 2 - 4m	2 basins Internal dimensions of one basin	
Drying bed	Number of beds Water Depth		4 beds More than 1m	More than two beds More than 1m	4beds	
Administration Building			3 floors >Administration office, Laboratory, Control room, Meeting room, Chemical feeding room (PAC, Lime, Powder Chlorine), Storage space of pipe material		3 floors >Administration office, Laboratory, Generator, Control room, Meeting room, Chemical feeding room (PAC, Lime)	Pursat WWs request to prepare the storage space of pipe material.
Chemical building			Not construct (The space include Administration Building)		Container room, Chlorinator room, Neutralization room	Chlorine agents : Powder chlorine (Not chlorine gas)
Pump Station			Pumps, Panels, Generator,		Pumps, Panels,	Pursat WWs requires the generator to be changed to be installed elsewhere. The Team propose it to be installed Pump Station.
Electrical Standard			ISO, IEC, JIS, JEC, JEM		ISO, IEC, JIS, JEC, JEM	
Substation			22/0.4kV from EDC power line, received in WTP	Depend on EDC (Electricity of Cambodia)	22/0.4kV from EDC power line, received in WTP	
Emergency diesel generator			100% capacity for all lords		100% capacity for all lords	
Load Power Factor			More Than 95%		More Than 95%	EDC requirement
Motor Rated Voltage			380V		380V	
Motor for Distribution Pump			Variable Speed Motor		Variable Speed Motor	
Method of Speed control			Discharge Pressure control		Discharge Pressure control	
Filter Control			Automatic Control		Automatic Control	
Monitoring Panel of			Self- Standing Graphic Panel		Self- Standing Graphic	

Name of Equipment & Facilities, etc.	Design criteria applied to the project			Reference		
				Japanese Design Criteria	Example of similar projects in Cambodia	Request
WTP					Panel	
Monitoring system			Flow rate & Pump operation status		Flow rate & Pump operation status	

Annex-4 Future Supply Area



Annex-5　Draft Facility Planning and Design Policy for Water Supply Facilities (Raw Water Transmission and Distribution System

■ <u>Design Policy on Raw Water Transmission And Distribution System</u>

- The selection of suitable routes of laying of transmission mains and distribution mains, the durability, prevention of water pollution in the transmission mains, the ease of maintenance, economic benefits, energy efficiency

■ <u>Design Criteria</u>

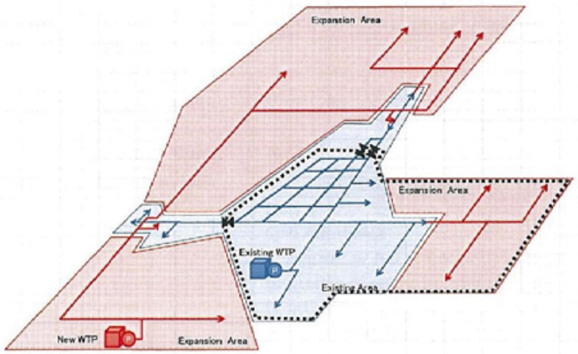
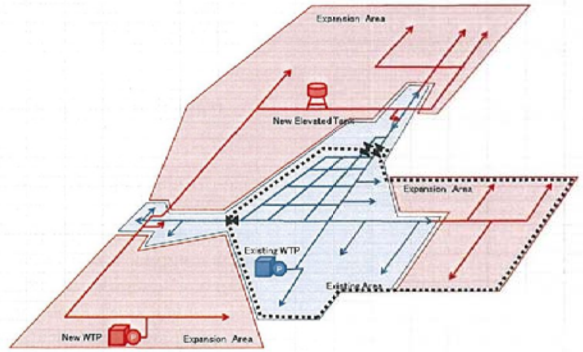
Facilities	Design criteria applied to the project			Reference	
				Japanese guideline	Example of similar projects in Cambodia
Raw water transmission	Design flow of raw water transmission		The design flow of raw water transmission facilities shall be based on the design flow of raw water intake.	The design flow of raw water transmission facilities shall be based on the design flow of raw water intake.	
	Type of raw water transmission		Pumping type, pipe conduit	Pumping type, pipe conduit	
	Raw water transmission mains	Pipe diameter	The pipe diameter shall be determined in consideration of the correlation between the pipe diameter and the annual cost.	The pipe diameter shall be determined in consideration of the correlation between the pipe diameter and the annual cost.	
		Flow velocity	The flow velocity shall be the most economic velocity	The flow velocity shall be the most economic velocity	
Service reservoir	Structure and type		RC	RC, PC, SS, SUS	Pursat: RC, Rectangle Kampong Cham: RC, Rectangle Battambang: RC, Rectangle Kampot: RC, Rectangle
	Capacity		The capacity of the service reservoir shall be 8 hours equivalent of the maximum daily supply of the service area. The firefighting water to be added to the above capacity (if necessary)	The capacity of the service reservoir shall be 12 hours equivalent of the maximum daily supply of the service area. The firefighting water to be added to the above capacity.	Pursat: 7.8 hours Kampong Cham: 5.2 hours Battambang: 6.5 hours Kampot: 3.5 hours
	Water depth	water depth	3～6m	3～6m	Pursat:5.5m Kampong Cham:3.8m

Facilities	Design criteria applied to the project			Reference: Japanese guideline	Reference: Example of similar projects in Cambodia
					Battambang:4.3m
	Distribution pump		Based on pipe network analysis H-W equation C=110	Based on pipe network analysis H-W equation C=110	Pursat: RC, Rectangle Kampong Cham: RC, Rectangle Battambang: RC, Rectangle Kampot: RC, Rectangle
Distribution mains	Design distribution flow		The design maximum hourly distribution flow in the service area	The design maximum hourly distribution flow in the service area	
			The ratio (K) of the design maximum hourly distribution flow to the average hourly flow shall be determined with reference to the experiences or the condition in the region with similar characteristics. K=1.5	The ratio (K) of the design maximum hourly distribution flow to the average hourly flows hall is determined with reference to the experiences or the condition in the region with similar characteristics. K=1.5-2.0	
	Water pressure	The minimum dynamic water pressure	More than 50- 100 kPa (0.05 0.10 MPa)	More than 100-150 kPa (0.10-0.15 Mpa)	
		The maximum static water pressure	Less than 740 kPa (0.74 MPa)	Less than 740 kPa (0.74 MPa)	
	Pipe diameter		Based on pipe network analysis H-W equation C=110	Based on pipe network analysis H-W equation C=110	

23

Annex-6　Draft Distribution System and Alignment of Pipelines

Table A6-1　Comparison of conceptual design for Distribution System

	Alternative (A)	Alternative (B)
Description	· Distribution pumps in new WTP directly distribute water to the service area. · The existing distribution pumps in the existing WTP directly distribute water to the modified service area having water demand amount corresponding to the capacity of those pumps /WTP.	· Distribution pumps in new WTP directly distribute water to the service area and also send water to elevated tank to regulate the distribution flow or control water pressure in the service area. · The existing distribution pumps in the existing WTP directly distribute water to the modified service area having water demand amount corresponding to the capacity of those pumps /WTP.
Schematic illustration		 A
The ease of operation and maintenance	· Easy compared to B	· A service reservoir is separately provided in the new WPT, and the distribution pressure is regulated by means of controlling pumps or inlet valves in relation to the water depth in the elevated reservoir. · A little difficult compared to A.
Construction cost	· Slightly cheaper compared to B · Construction cost includes a service reservoir, distribution pumps, and distribution mains.	· More expensive compared to B · Construction cost includes a service reservoir; distribution pumps distribution mains and an elevated tank.

24

	Alternative (A)	Alternative (B)
Energy efficiency	Total head of distribution pumps are comparable and B, energy saving can be expected by the inverter installation. Equivalent to Alternative B	Total head of distribution pumps are comparable and A, energy saving can be expected by the inverter installation Equivalent to Alternative A
	Recommendable	

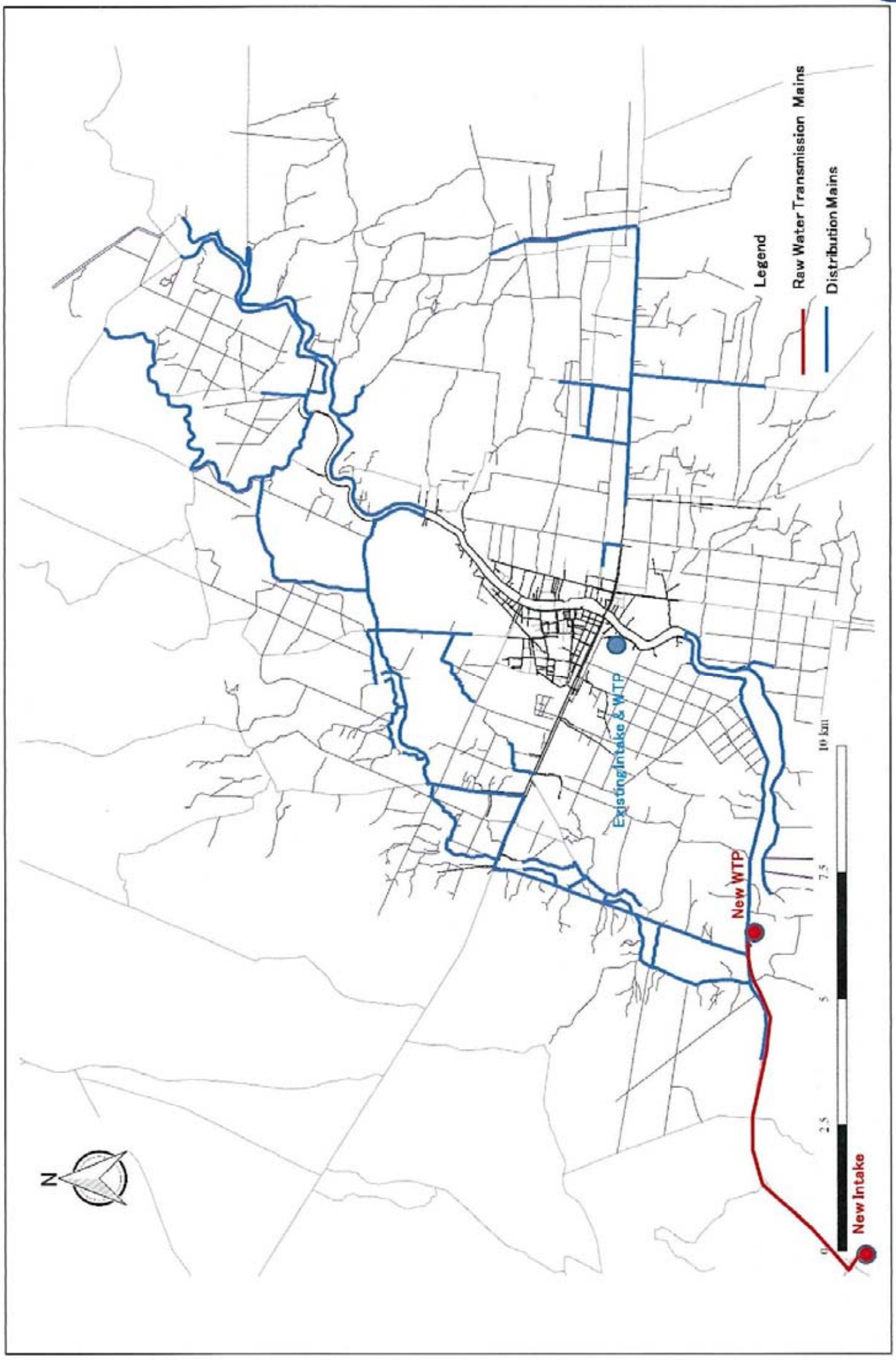


Figure A6-1　Alignment of Pipeline

26

Annex-7　Location of Temporary Yards and Dump Sites in Pursat

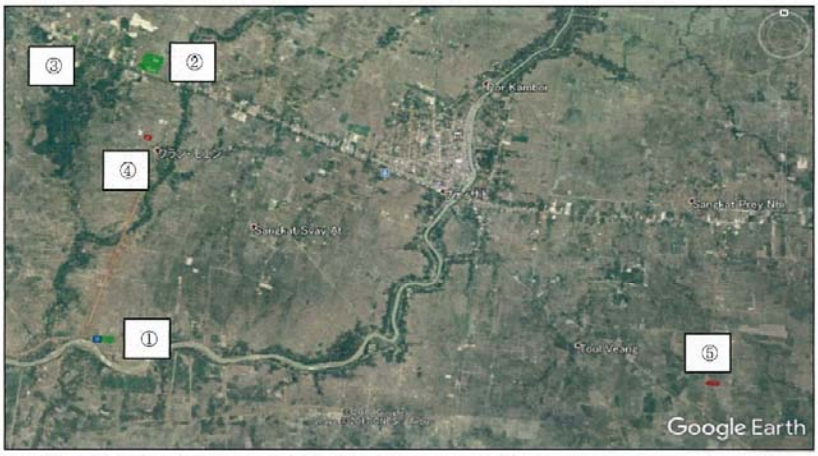


Figure A7-1　Site Location of Temporary Yards and Dump Sites in Pursat

Annex-8　Photos and sketch of Vay Kor Dam Structure

Figure A8-1　Vay Kor Dam During Placing Cobbles (Left) and After Placing Cobles (Right) against Scouring in the Downstream Side of the Dam

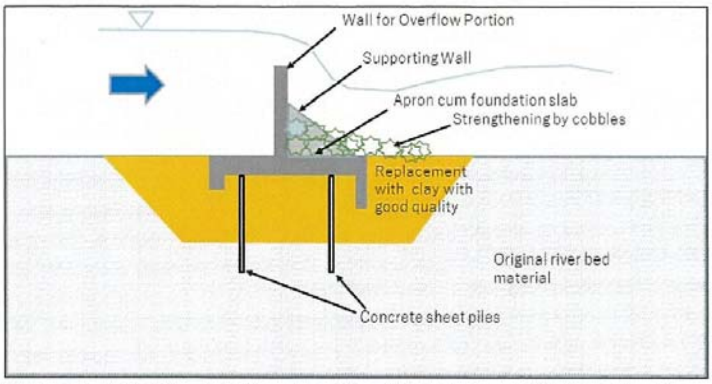


Figure A8-2 Sketch of the Structure of Vay Kor Dam (based on the Information from DOWRAM Svay Rieng Province)

TECHNICAL NOTES
ON
THE PREPARATORY SURVEY ON THE PROJECT
FOR EXPANSION OF WATER SUPPLY SYSTEM
IN PURSAT AND SVAY RIENG
IN THE KINGDOM OF CAMBODIA

Based on the Minutes of Discussions (hereinafter referred to as "M/D") on the Preparatory Survey on the Project For Expansion of Water Supply System in Pursat and Svay Rieng in the Kingdom of Cambodia (hereinafter referred to as "the Project") signed on August 24th, 2017 ,and Second Preparatory Survey for the Project signed on February 14th, 2019 between Japan International Cooperation Agency (hereinafter referred to as "JICA") and Ministry of Industry and Handicraft (hereinafter referred to as "MIH"), of the Government of Cambodia, the consultant members of the JICA Preparatory Survey Team (hereinafter referred to as "the Team") had a series of discussions and conducted field surveys from March 17th and will continue until April 12th, 2019.

As a result of the discussions and the surveys, both sides (MIH and the Team) confirmed the technical conditions described in the attached sheets of this note.

It should be noted that this technical note does not mean the commitment of the project scope, project implementation, design and method to be implemented. The final project scope, project implementation, designs, etc. will be decided by the Government of Japan.

Phnom Penh, April 10th, 2019

H.E. Yea Bunna	Mr. Hideki Konno
Director General	Chief Consultant
General Department of Portable Water Supply	Preparatory Survey Team
Ministry of Industry and Handicraft (MIH)	Japan International Cooperation Agency (JICA)

1

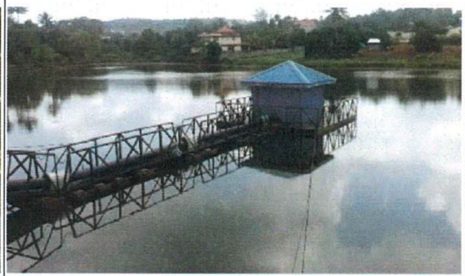
ATTACHMENT

Both sides agreed upon and confirmed the following items.

1. Intake Facilities

The Team explained alternative intake facilities such as rail type and pontoon type intake facilities shown in **Table 1.**

Table 1 Comparison of Intake Facilities

Items	Case1 Rail Type Intake Facility	Case2 Pontoon Type Intake Facility
Photo		
Summary	- The intake pump unit (house) moves upward and downward following seasonal water level fluctuation of the river. The pump house will be pulled up by electrical winch. - Dry pumps are applied.	- The intake pump unit (house) moves upward and downward following seasonal water level fluctuation of the river. - The electricity for pump house movement following the water level fluctuation is not required. - Submergible pumps are applied.
Characteristic	- It takes electric cost for pump house movement in response to the river water level. - Frequent pipe remove and reconnection will be required. - Frequent cleaning along the rail against deposited mud and accumulated waste materials.	- The electric cost can be reduced. - It is no need to remove and reconnection of pipe materials frequently. - The truss unit and pipes are connected by flexible joint materials in order to follow the water level fluctuation.
Applicability		○

The Team explained that it is better to adopt pontoon type intake facility because of easier maintenance and less electric cost than rail type intake facility. MIH agreed to adopt pontoon type intake facility whose drawing and specification shown in **Figure A1-1** and **Table A1-1.** The maintenance items for pontoon type intake facility are (1) cleaning of flown litter, branches and leaves etc. around the pontoon, (2) periodical painting for rust prevention and (3) maintenance of the parts of intake pump such as impeller, shaft and bearing etc.

With reference to the method of settling the sedimentation at the intake site, the Team explained to provide sand basin (elevated type) instead of ground type sand basin on the original design. The MIH and Team agreed to adopt sand basin (elevated type) at the land side of intake facility site instead of ground type sand basin considering the cost estimation result and affordability of budget to provide the sand basin (elevated type) shown in sample **Figure A1-2**.

Cambodian side requested to have remote control system in new treatment plant, not only monitoring system for intake facility operation.

2. Design Coverage Area and Distribution System

The Team and MIH agreed to modify design coverage area and distribution system according to minutes of discussion (MD) on February 14th, 2019. The Team collected latest population data for administrative area and coverage area, and the Team also investigated current distribution system status to examine the proper water distribution system such as the range of coverage area and distributed metered area (DMA). The collected data for confirmation of distribution system status is such as distribution trend data, distribution pressure on 13 locations, residual chlorine data and pump operation sheet. The target survey areas are 13 communes in 3 districts. As a result, some villages in northern area of coverage area on original design are excluded from proposed coverage area based on the following reasons.

a) The population in the existing coverage area is on the increasing trend.

b) The daily maximum water supply amount based on the current distribution pump operation record exceeds 7,260m^3/day of the existing water treatment plant capacity. There are some data that the water supply amount sometimes reaches to 8,000 m^3/day.

c) The water pressure monitoring result on 24 hours shows high water consumption in the existing coverage area especially around of Pursat Market.

Based on the above reasons, the Team proposed the following design policy for confirmation of design coverage area and distribution system;

1) Some villages in northern area of coverage area on original design are excluded from proposed coverage area and some distribution pipes from coverage area on original design are removed.

2) The existing coverage area shall be divided and classified into separate DMAs. The scale of DMA including existing water treatment plant shall be set in accordance with the capacity of existing water treatment plant. The other new DMA will enhance the distribution capacity of the existing coverage area by combining the part of the existing coverage area and new coverage area as the new DMA.

3) Based on the above, revised figure of DMA is shown as "ATL_2" in **Figure 1.**

Based on the above design policy, the Team will conduct the project cost estimation and evaluate the proper level of pipe length reduction.

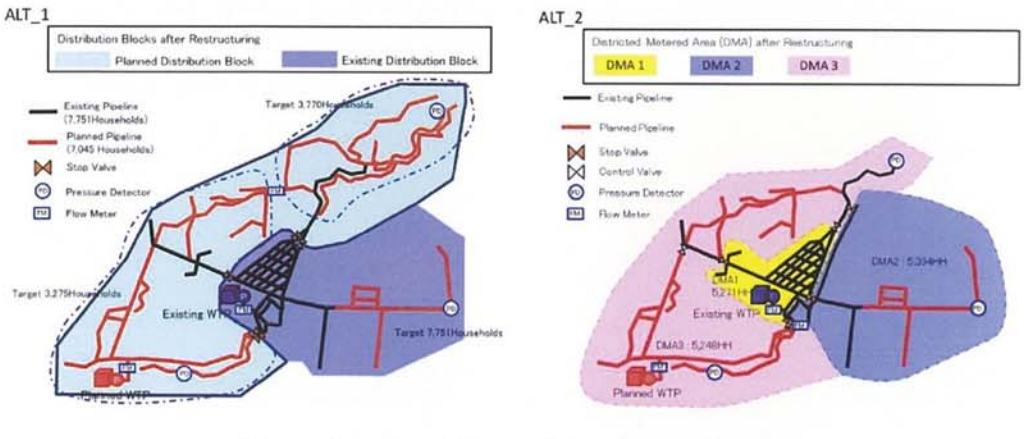


Figure 1 Illustration of DMA (Distributed Metered Area)

3

3. Demand Projection

MIH requested the Team to conduct water demand projection in 2025. By this year, the target water supply ratio of urban areas in provincial cities are disseminated in the MIH to be 100%. MIH explained that the target service ratio shall be 90 % by piped water and remaining 10% will be covered by other measures. The Team explained that the design water supply population will be 77,525 persons and the design service ratio on this Project will be about 88.6% for urban area (The service ratio for administrative area on this Project is 70.1%). The definition of urban area is based on the "Reclassification of Urban Areas in Cambodia, 2011 by National Institute of Statistics, Ministry of Planning".
The Team explained other factors for the demand projection as below;

- Future population is based on the following information.
  - Results of 1998, 2008 and 2013 census.
  - Village level population data between 2006 to 2018 from Pursat provincial waterworks.
- 13 communes in 3 districts shall be set as proposed coverage area of Pursat in the target year
- Per Capita Consumption per day in the target year is set as 100L based on the record from Pursat provincial waterworks during 2014 to 2018. The consumption of industrial, public and commercial water supply amount is also estimated based on the trend of water supply amount during 2014 to 2018.
- Non-revenue water ratio is set to 15% based on the ministerial ordinance of the MIH. Leakage ratio is set to 11.3% which is 75% of non-revenue water ratio based on past experience of similar projects.
- Loading factor is set as 82.3% based on the record from waterworks during 2015 to 2018.
- Existing WTP capacity in the target year is set as 7,260m^3/day.

The Team explained that based on the estimation, the capacity needed by the Project in 2025 is about 6,600m^3/day for Pursat. Cambodian side agreed on it.

4. Social and Environmental Considerations

The Team explained the design change contents of intake facility such as pontoon type intake facility and sand basin (elevated type). The MIH confirmed to conduct the necessary procedures concerning the environmental assessment with assistance from the Team. The IEIA approval shall be received from the responsible authorities and submitted to JICA by the end of 2019.

5. Procurement of Equipment and Spare Parts

- As for the individual house connection for poor households, necessity of provision of the materials such as water meters, fittings and pipes in the Project will be examined in consideration of similar projects. Based on the information from Pursat WWs, 60 % of poor level 2 households can bear the pipe connection material cost by beneficiaries. The MIH and the Team agreed to reduce the procurement number of poor household's pipe connection materials covered by Japan side related to the part of poor level 2 households and the excluded northern part households from the coverage area.
- Cost reduction will be examined by following order as confirmed by minutes of discussion (MD) on February 14, 2019. On the other hand, with regard to the reduction of equipment shown in **Table-2**, since there are some items that cannot be procured in Cambodia such as laboratory equipment, Pursat

WWs requested to the Team not to reduce these items as much as possible. The Team explained that the reduction priority for equipment will be examined based on the result of project cost estimation after the completion of design change.

1) Change of procurement country of pipe and reduction of assessment rate, equipment and spare parts
2) Modification of coverage area
3) Change of intake facility
4) Change of pipe specification (pressure durability and flow coefficient)
5) Size reduction of sedimentation basin
6) Change of pipe specification (time coefficient)
7) Size reduction of clear water reservoir

Among the equipment items shown in **Table 2**, the Cambodian side agreed to reduce the items on shaded cells with priority in case that the project cost is not within the budget of the grant aid.

Table 2 Procurement of Equipment

Classification of Equipment to be Procured		Contents of Initial Request	Equipment to be Procure based on Field Survey Results
Procurement of Equipment	Sediment evacuation equipment for existing intake pit	-	One set of submersible sand pump, One set of power generator for driving submersible sand pump
	Equipment for Water quality management	Atomic absorption photometer, distillation equipment, microscope, reagents, glassware, turbidimeter, pH meter, UPS etc.	Jar tester, distilled water maker, pH meter, residual chlorine meter, conductance meter, water bath, microscope, continuous water quality analyzer for conductivity and residual chlorine, absorptiometer, UPS, microorganism analyzer, reagents, glassware, laboratory tables, etc.
	Equipment for electric machine	Power tester, detector, vibrometer, torque wrench, handy flowmeter, filter sand tester, insulation checker, etc.	Clamp power meter, vibration checker, mechanical torque wrench, portable ultrasonic flow meter and sieve shaker
	Equipment for management of distribution pipes	Leak detector, pipe detector, laying pipe equipment, pipe network information system etc.	Laying pipe equipment: Socket fusion
	Equipment and materials for house connection to poverty households	-	Water supply pipes, water meters and accessories
	Accounting system	-	SUMS System (PC and extra software license)

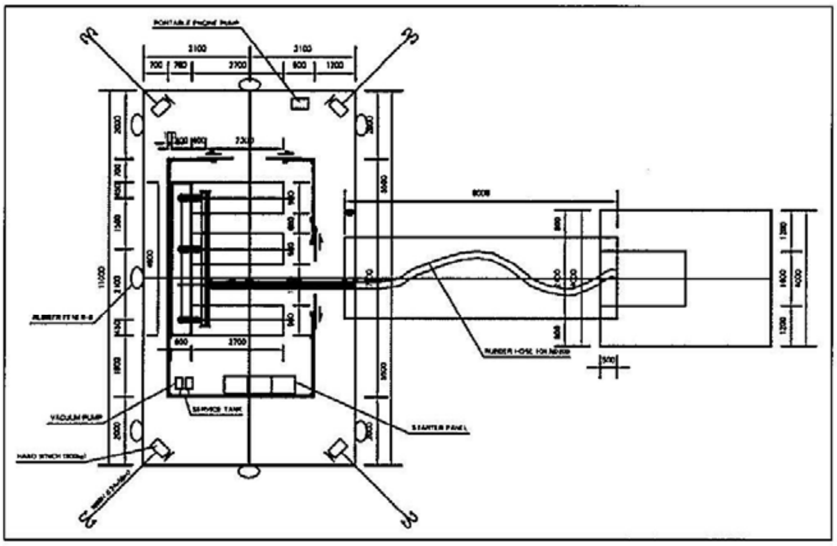
Source: JICA Survey Team

6. Schedule of the Project

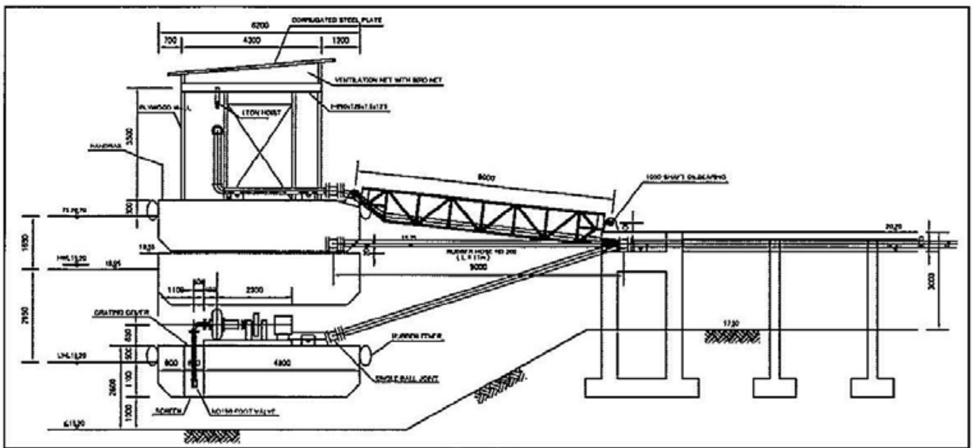
The project schedule for the time being for this project is as follows;

Items	2019											
	1	2	3	4	5	6	7	8	9	10	11	12
Preparation in Japan	—											
Field Survey in Cambodia		■										
Work in Japan		—	—									
Field Survey in Cambodia			■	■								
Analysis in Japan				—	—	—	—	—				
Briefing Outline Design to Cambodian Side								■				
Submission of Preparatory Survey Report											▲	
Key Meeting with Cambodian Side		▲		▲				▲				
Cabinet Meeting in Japan											▲	

Annex-1　Intake Facility (draft)



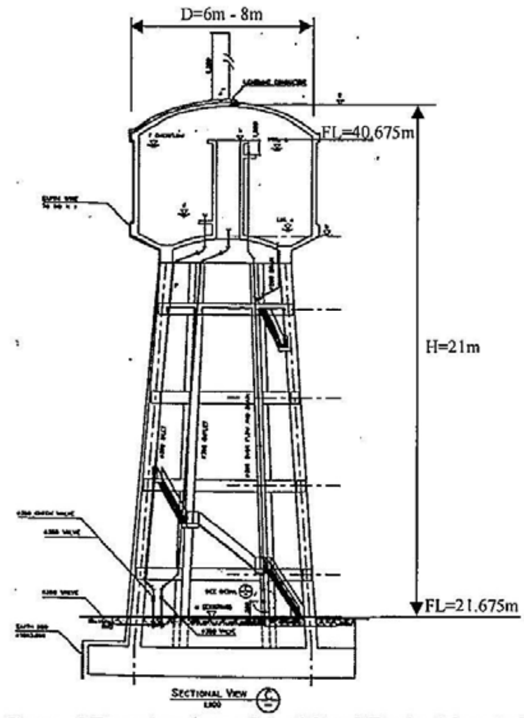
Plan of Intake Facility



Section

Figure A1-1　General Drawing of Intake Facility

6



Note: The dimensions are provisional values.

Figure A1-2　General Drawing (sample) of Sand Basin (elevated type)

Table A1-1　Outline Specification for Intake Facility

No.	Item	Detail	Specification (provisional value)
1	Intake Facility 7,260m³/day	Sand Basin (elevated type)	H=21m, D=6m-8m Inlet pipe ϕ 200(ϕ 100 x 3), Outlet pipe ϕ 350, Drain pipe ϕ 150 x 3, Overflow ϕ 200
2		Pontoon Facility	Floating barge L11.0m x W6.2 x H1.6m Equipped facility: incoming panel, control panels, intake pump (2.52m³/m x 3 sets), vacuumed pump 0.75kw, portable engine pump 4.7kw, suction hose ϕ 200, chain hoist 1t, hand winch
3		Generator House	Rectangular reinforced concrete structure Size: L9.0m x W7.5m x H3.5m (measuring under beam center of the walls) Equipped facility: generator, fuel tank, chain hoist 1t

Table-A2-1 Water Demand Projection

Record ←　→ Prospect

項　目		単位	式	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Population in Administrative Area	total	person	A	40,979	51,597	51,597	97,317	100,422	98,243	99,691	102,418	103,770	105,122	106,475	107,827	109,179	110,531
	urban	person		35,259	44,043	44,043	65,546	67,539	65,296	66,332	68,542	69,487	70,433	71,378	72,323	73,269	74,214
	rural	person		5,720	7,554	7,554	31,771	32,883	32,947	33,359	33,876	34,283	34,690	35,097	35,503	35,910	36,317
Population in Water Supply Area	total	person	B	40,979	51,597	51,597	56,330	57,994	57,543	57,738	59,279	60,007	60,736	61,465	84,841	85,929	87,017
	urban	person		35,259	44,043	44,043	46,851	48,137	47,566	47,718	49,086	49,694	50,301	50,908	66,626	67,459	68,292
	rural	person		5,720	7,554	7,554	9,479	9,857	9,977	10,020	10,192	10,314	10,435	10,557	18,214	18,470	18,725
Water Supply Population	total	person	C	24,652	29,773	32,549	33,572	35,682	36,885	37,661	39,921	40,719	41,533	42,577	56,594	66,809	77,525
	urban	person		22,011	26,584	29,063	29,976	31,843	32,912	33,658	35,677	36,391	37,119	37,972	48,861	57,087	65,729
	rural	person		2,641	3,189	3,486	3,596	3,839	3,973	4,003	4,243	4,328	4,415	4,606	7,733	9,723	11,796
Water Supply Ratio in Administrative Area	total	%	D = C/A x 100%	60.2	57.7	63.1	34.5	35.5	37.5	37.8	39.0	39.2	39.5	40.0	52.5	61.2	70.1
	urban	%		62.4	60.4	66.0	45.7	47.1	50.4	50.7	52.1	52.4	52.7	53.2	67.6	77.9	88.6
	rural	%		46.2	42.2	46.2	11.3	11.7	12.1	12.0	12.5	12.6	12.7	13.1	21.8	27.1	32.5
Water Supply Ratio in Water Supply Area	total	%	E = C/B x 100%	60.2	57.7	63.1	59.6	61.5	64.1	65.2	67.3	67.9	68.4	69.3	66.7	77.7	89.1
	urban	%		62.4	60.4	66.0	64.0	66.2	69.2	70.5	72.7	73.2	73.8	74.6	73.3	84.6	96.2
	rural	%		46.2	42.2	46.2	37.9	38.9	39.8	40.0	41.6	42.0	42.3	43.6	42.5	52.6	63.0
Water Supply Households	total	house	F	5,016	6,005	6,475	6,860	7,252	7,510	7,657	8,130	8,293	8,459	8,671	11,526	13,607	15,789
	urban	house		4,476	5,359	5,778	6,122	6,472	6,701	6,843	7,266	7,412	7,560	7,734	9,951	11,627	13,387
	rural	house		482	577	622	659	696	722	727	864	881	899	938	1,575	1,980	2,402
Water Supply Households (Poor Households)	total	house	G = F x poor household ratio	672	805	868	919	972	1,006	1,026	1,089	1,111	1,133	1,162	1,545	1,823	2,120
	urban	house		577	691	745	790	835	864	883	937	956	975	998	1,284	1,500	1,730
	rural	house		78	93	101	107	113	117	118	140	143	146	152	255	321	390
Average Water Consumption per Person per Day for Household		L/day/person	H	106.1	99.5	98.8	104.5	112.4	100.2	105.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Average Water Consumption per Day for Household		m^3/day	I = H x C ÷ 1000	2,615	2,963	3,215	3,509	4,012	3,695	3,972	3,992	4,072	4,153	4,258	5,659	6,681	7,752
Average Water Consumption per Day for Business and Institution		m^3/day	J	390	454	538	829	1,037	1,228	1,259	1,459	1,607	1,755	1,903	2,051	2,199	2,347
Effective Water Amount (total)		m^3/day	K = I+J	3,005	3,417	3,753	4,338	5,049	4,923	5,231	5,451	5,679	5,908	6,161	7,710	8,880	10,099
Ineffective Water Amount		m^3/day	L = M - M x (R/100)	438	466	447	398	415	380	376	691	720	749	781	977	1,126	1,280
Daily Average Water Supply Amount		m^3/day	M = K ÷ R x 100	3,443	3,883	4,200	4,736	5,464	5,303	5,607	6,141	6,399	6,657	6,942	8,687	10,006	11,379
Average Water Consumption per Person per Day		L/day/person	N = M ÷ C x 1000	140	130	129	141	153	144	149	154	157	160	163	154	150	147
Daily Maximum Water Supply Amount		m^3/day	O = M ÷ T x 100	4,312	4,826	5,647	5,767	6,668	6,114	6,757	7,458	7,770	8,083	8,430	10,549	12,150	13,819
Maximum Water Consumption per Person per Day		L/day/person	P = O ÷ C x 1000	175	162	173	172	187	166	179	187	191	195	198	186	182	178
Revenue Water Ratio		%	Q	83.0	84.0	85.8	88.8	89.9	90.4	91.1	85.0	85.0	85.0	85.0	85.0	85.0	85.0
Effective Water Ratio		%	R = 100% - S	87.3	88.0	89.4	91.6	92.4	92.8	93.3	88.8	88.8	88.8	88.8	88.8	88.8	88.8
Leakage Water Ratio		%	S = (100% - Q) x 0.75	12.7	12.0	10.6	8.4	7.6	7.2	6.7	11.3	11.3	11.3	11.3	11.3	11.3	11.3
Loading Rate		%	T = M ÷ O x 100%	79.8	80.5	74.4	82.1	81.9	86.7	83.0	82.3	82.3	82.3	82.3	82.3	82.3	82.3
Construction Period												←	—	→			
Existing Capacity		m^3/day		5,760	5,760	7,260	7,260	7,260	7,260	7,260	7,260	7,260	7,260	7,260	7,260	7,260	7,260
Capacity required by this Project		m^3/day											823	1,170	3,289	4,890	6,559